

Real-time Operating Systems and Systems Programming

Introduction to Real-Time Operating Systems Lecture 2

Pointless fact of the day

*Luxury cars have 100M lines of code,
more than Dreamliner 787
- Discovery News*

1 year	32 nHz	year number rollover
6 months	64nHz	GMT ↔ BST changeover
8hr	30μHz	AGA coal stove cycle time
10s	0.1Hz	photocopier page printing
1s	1Hz	time-of-day rate
300ms	3Hz	human typing speed
300ms		human reaction time
150ms	7Hz	mechanical switch bounce time
15ms	70Hz	motor car engine speed
	260Hz	middle C
	440Hz	concert pitch A
1ms	1kHz	serial line data rate
125μs	8kHz	digitized speech, telephone quality
64μs	15.6kHz	TV line rate
50μs		Mc68000 interrupt latency
0.5μs	2Mhz	Mc68000 instruction rate
0.075μs	13.5MHz	Video data rate
0.050μs		semiconductor RAM access time
0.01μs	100MHz	Ethernet data rate
10ns	100MHz	memory cycle, PC motherboard
2.5ns	400MHz	logic gate delay
555ps	1.8GHz	cellular telephone transmission
500ps	2GHz	single instruction issue, Pentium IV
0.3ps	3THz	infrared radiation
16fs	600THz	visible light

Topics

- Operating Systems
- Real-time Operating Systems (RTOS)
- Project discussion

Operating systems

- Interface between hardware and software
- Provide services for applications
- Provide an abstraction layer for hardware

What services?

- Processes
- Multitasking
- Interrupts
- Memory management
 - Virtual memory
- Protected/supervisor mode
- Disk & Files
- Booting the computer
- Device drivers
- Networking
- Users / authentication
- Graphical UI

What applies for Real-time?

Usually not included in RTOS

- Paged & swappable virtual memory management
- Disk filing system
- Full networking facilities
- Intertask security
- Multi-user support
- GUI

Real-Time Operating System

- Gives more options for prioritizing
- Minimal *critical sections*
- Consistency of *jitter*
- Different scheduling
 - Minimal interrupt latency
 - Minimal thread switching latency
- Predictability here is better than speed

More power (and responsibility)

- Interrupts can be masked
 - Can used only if max. int. latency (by specification) longer than longest critical section path
- Memory allocation
 - Fixed-size blocks
 - Re-entrant core libraries (allocation on stack)

Other services

- HW initialization
- Real-time clock management
- Critical resource protection
- Intertask communication
- Intertask synchronization
- I/O management
- Multiple interrupt servicing
- Memory allocation and recovery
- Assistance for debugging

Lifecycle of professional programmer

- Bodge
- Bloat
- Buy

POSIX

- POSIX (**P**ortable **O**perating **S**ystem Interface [for Uni**X**])
- Standard for Unix, defines core specifications-
command-line, shell, some programs, basic
IO.Threading API.

Linux

- Not a real time system

- BUT

- RTlinux

- Also needs 32bit CPU

- Kernel pre-emption since 2.6

Response delay

Standard o/s	1-100ms
Desktop Linux	1-10ms
RTE	1-10 μ s
RTLinux	1-10 μ s

RTLinux strategy

- Micro-kernel HAL
- RT tasks run in kernel space, separate from kernel

Scheduling strategies

- Round-robin
- First come first served
- Prioritized queueing
- Deadline prioritization
- Shortest first
- *Pre-emptive*